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(Mis)informed During COVID-19: How Education Level and Information Sources Contribute to Knowledge Gaps

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As COVID-19 swept across the globe, disrupting people's lives through lockdowns and health concerns, information about how to stay safe and how to identify symptoms spread across media of all forms. Using survey data we collected in April 2020 on a national sample of Americans, we tested the knowledge gap hypothesis by examining how people's education levels relate to their knowledge about COVID-19 as well as their susceptibility to fake news, and whether information sources moderate this relationship. Our findings suggest that a knowledge gap exists, with those with higher education levels displaying higher levels of knowledge. In contrast, education level did not play a role in believing false information. Moreover, higher news consumption through radio, print newspapers and magazines, and especially social media was associated with lower levels of knowledge and more fake news beliefs. However, news media consumption did not moderate the relationship between education and either knowledge or fake news beliefs, meaning that the media did not explain the education-based knowledge gap during the early months of the COVID-19 pandemic.

Keywords: knowledge gap hypothesis, misinformation, fake news, traditional media, digital media, COVID-19

The health crisis linked to the spread of a new coronavirus (COVID-19) in spring 2020 created a serious communication challenge as countries tried to contain the global pandemic. Since the beginning of COVID-19, government authorities and media tried to communicate what was known day by day about the symptoms, the precautionary measures to avoid contagion, and the guidelines to follow as part of lockdown policies (Mitchell & Oliphant, 2020). Receiving and understanding information about the new virus could make the difference between health and illness, or worse, death. Rarely has fast and widespread

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understanding of information been so vital. However, a concurrent spread of misinformation related to COVID-19 emerged with the potential to prevent people from obtaining accurate advice (Jurkowitz & Mitchell, 2020a). In this article, we investigate people's knowledge of COVID-19 in the early weeks of the pandemic in the United States to understand who was and was not informed about factors that could contribute to people's ability to protect themselves, protect others, and thereby also keep pressure off the health-care system.

According to the broad literature about the "knowledge gap hypothesis," when information about a topic enters a social system, segments of the population with higher resources are better able to acquire this information "so that the gap in knowledge between these segments tends to increase rather than decrease" (Tichenor, Donohue, & Olien, 1970, pp. 159–160). This theory has been applied and tested in a great number of studies that have, in general, confirmed that knowledge is acquired differently according to education level (for a review of this literature, see Lind & Boomgaarden, 2019). However, previous work on the knowledge gap hypothesis has mostly focused on general knowledge built in the long run (e.g., static political and civic knowledge, health-related information; Barabas, Jerit, Pollock, & Rainey, 2014). As far as we know, such studies have not addressed knowledge concerning a health crisis of global scope, severity, and immediacy. Although the knowledge gap hypothesis was tested during the H1N1 flu pandemic (Ho, 2012), this disease outbreak was much less widespread than the COVID-19 global pandemic. Unique to the COVID-19 pandemic is that people's knowledge about it was developing in a very short time span, as the virus spread rapidly worldwide.

Research about knowledge gaps has highlighted the role of the media in shaping informational disparities. There is evidence that different media can impact knowledge gaps differently—amplifying, maintaining, or narrowing them. Across a wide range of studies, television appears to maintain existing gaps while print media and digital media seem to increase knowledge inequalities between groups with different educational attainment (Lind & Boomgaarden, 2019). Other studies have addressed knowledge gaps attributable to digital media use (Bonfadelli, 2002; Shaw & Hargittai, 2018), and social media in particular, showing an amplifying effect, especially in the case of the latter (Yoo & Gil de Zúñiga, 2014).

Specific to online information about the novel coronavirus pandemic is also the wide circulation of fake news on social media about the origin of the virus, how it spreads, safety recommendations, and cures (Jurkowitz & Mitchell, 2020b; Spring, 2020). An unpublished study found that English-language state-backed online news outlets from China, Iran, Russia, and Turkey generated a great deal of content on conspiracy theories about the coronavirus, with millions of people worldwide engaging with and sharing such content on social media (Bright et al., 2020). The widespread diffusion of fake news about COVID-19 makes it a noteworthy case to investigate from the perspective of the knowledge gap hypothesis because it allows the examination of not only varied knowledge, but also susceptibility to misinformation.

To test whether the knowledge gap hypothesis extends to the case of information diffusion during the COVID-19 pandemic, we analyze data we collected from a national sample of Americans approximately three weeks after lockdown measures were implemented across the United States. We focus on respondents' knowledge about the incubation time of the virus, common symptoms, effective procedures of social distancing to reduce the risk of being infected and infect others, and measures to be followed in case of

alleged contagion. We first examine if education level relates to people's knowledge attainment, as well as whether daily information gathering through different traditional media sources (television, radio, and print media) and digital media sources (Internet news, social media) does. Next, we test how people's uses of these different information sources interact with education level in decreasing or increasing knowledge gaps. Given our extensive knowledge measures, we are also able to explore the same dynamics looking at an alternative outcome that addresses belief in misinformation or fake news. We end by discussing the theoretical and policy implications of our findings.

Education and Knowledge Gaps

The knowledge gap hypothesis posits that socioeconomic status, and education level in particular, is positively associated with knowledge levels on specific topics, and that the difference in such levels grows as the quantity of information grows in a social system (Tichenor et al., 1970). An increase in the amount of information offered by media on a topic will mainly benefit higher socioeconomic segments of the population, which tend to acquire this information more easily and faster than their disadvantaged counterparts (Tichenor et al., 1970). There is considerable evidence of knowledge gaps based on educational attainment for various topics, such as health and medical issues (e.g., cancer), science issues other than health (e.g., earth satellites), and social and political issues (e.g., political issue stance, city budget; for meta-analytical reviews, see Hwang & Jeong, 2009; Lind & Boomgaarden, 2019). Additionally, higher educated people may be better at dealing with information overload and Internet overuse (Gui & Büchi, 2021), something that characterized COVID-19's lockdown period. Indeed, a report by the Pew Research Center showed that a majority of Americans found the situation emotionally burdening and took breaks from the news already in the early months of the pandemic (Mitchell, Oliphant, & Shearer, 2020). Accordingly, being able to extract the most relevant and reliable information is not self-evident, especially at a time of high stress and a deluge of information.

Specific Sources of Information and Knowledge Gaps

Research shows that media exposure can amplify knowledge gaps. For example, Yang and Grabe (2011) found that more educated people acquire more knowledge from news media use so that gaps increase with use. Bonfadelli (2005) came to similar conclusions using data from Eurobarometer surveys carried out in 1996 and 1999. In a study on general health knowledge among cancer patients, education explained different health information-seeking behaviors, which in turn positively moderated the association between Internet use for health information and general health knowledge (Lee, 2009). A different study found that more educated people were more likely to use the Internet for cancer information, which increased the cancer knowledge gap (Shim, 2008).

Different types of media have different implications for the formation and maintenance of knowledge gaps based on educational attainment. When it comes to traditional news sources, research has overall indicated a relevant difference between the impact of television and other media. Such difference reflects the specificities of traditional media highlighted by media theory in terms of audience differentiation: Whereas major television channels represent the typical case of "audience concentration," where standardized content is broadcast to large and socially diverse audiences, newspapers more

frequently reflect the geographical, political, and social diversity of a country's citizens (McQuail, 2010). Beckers, Van Aelst, Verhoest, and d'Haenens (2020) found that even controlling for personal interest and general knowledge, people consuming news content from both public television service and commercial broadcasting news know more about current affairs. Moreover, Eveland and Scheufele (2000) found that education-based political knowledge gaps were smaller among heavy television users compared with light television users, while this relationship was less pronounced for newspaper use. Similarly, a study on science knowledge found that newspaper consumption had no effect on the formation of knowledge gaps, while television among lower educated groups could help close gaps (Cacciatore, Scheufele, & Corley, 2014). Boukes and Vliegenthart (2019) also showed that television particularly benefits knowledge acquisition by lower educated people, while learning through newspaper consumption seemed independent of education level.

Other research points to the role of newspapers in amplifying knowledge gaps. Based on the 1997, 2001, and 2005 Norwegian election studies, Jenssen (2013) showed that television works as a maintainer and newspapers as an enhancer of political knowledge gaps. Indeed, in the most recent and comprehensive meta-analysis to date, Lind and Boomgaarden (2019) find that television fulfils a role as a knowledge gap maintainer, while print media appears to increase knowledge inequalities between groups with varied educational background. Finally, the authors reported that only two of the studies included in the meta-analysis focused on radio, suggesting a slight, but nonsignificant, gap-widening effect.

The literature on knowledge gaps has also addressed the role of digital media in gathering information, presenting mixed theory and evidence (e.g., Cacciatore et al., 2014; Jeffres, Neuendorf, & Atkin, 2012; Yang & Grabe, 2014). Theoretically speaking, the Internet can exercise two opposing influences on knowledge. On the one hand, it can facilitate informational engagement through the lower cost of communication, because users can devote less time and effort to seeking specific information (Farrell, 2012). This notion has been supported by studies showing that looking for online news increases knowledge among both less and more educated people (Boukes & Vliegenthart, 2019; Cacciatore et al., 2014). On the other hand, the Internet can also have a polarizing role on knowledge gaps, given that higher educated people are more active in their use of the Internet and more oriented to gathering information (Bonfadelli, 2002; Tsetsi & Rains, 2017). A study conducted in South Korea found greater knowledge gaps across education levels among heavy users of political websites (Kim, 2008). In the American context, a study showed that young people with higher education are more efficient in using the Internet for learning (Cho, Gil de Zúñiga, Rojas, & Shah, 2003). A number of studies have found that digital media use is the greatest contributor to knowledge inequalities between groups with discrepant educational attainment compared with television, newspaper, and radio consumption (Jeffres et al., 2012; Yang & Grabe, 2011, 2014).

Today, many people are exposed to news online via social media channels, whether this is because they prefer to seek it out there (Geiger, 2019; Shearer, 2018) or due to incidental exposure (Fletcher & Nielsen, 2018). In earlier days of the Internet, online news consumption was considered a pull activity, where users actively gathered online news themselves (Bonfadelli, 2002). News consumed through social media can be considered as more of a push experience, given that news feeds provide users with non-searched-for information that is shared through social network sites (Beckers et al., 2020). For instance, Hermida, Fletcher, Korell, and Logan (2012) noted the practice of "receiving" news on social media. Through

an online survey of 1,600 Canadians, they showed that two fifths of social network site users said they received news from people they followed on services like Facebook, while a fifth got news from news organizations and individual journalists they followed. Research suggests that social media news consumption contributes less to users' knowledge than traditional media (print and audiovisual; Beckers et al., 2020). There is also evidence that getting informed through social media can reinforce knowledge gaps. Drawing on U.S. national survey data, Yoo and Gil de Zúñiga (2014) found that Facebook use interacted positively with education in predicting both general civic knowledge and issue-specific knowledge regarding recent events. Their findings suggest that the more educated gain more information from their use of social media for news, whereas this is not the case for lower educated people. Given the large amounts of COVID-19 information—including misinformation—circulating on social media, the question of whether this has affected knowledge gaps bears further examination.

Knowledge Gaps in Health Crises

Previous research on the knowledge gap hypothesis has mainly focused on issues related to the political sphere, public affairs, and general health and science knowledge—in all cases, knowledge that is accumulated over time (Lind & Boomgaarden, 2019). To our knowledge, only a few studies have addressed knowledge gaps during immediate health or climate crises. Spence, Lachlan, and Burke (2011) surveyed 691 Houston-area residents just before the arrival of Hurricane Katrina and found that socioeconomic status did not predict how much people knew about the storm, which may suggest lack of a knowledge gap in terms of understanding the storm's severity and potential consequences. In a study conducted in Singapore about the H1N1 influenza, education level was positively associated with knowledge (Ho, 2012). Attention to newspapers did not amplify the knowledge gap, while attention to television news was associated with a smaller knowledge gap. These differing findings suggest that there is a need for more work on knowledge gaps and the role of varying information sources during the time of unexpected events.

The COVID-19 pandemic offers an opportunity to test the knowledge gap hypothesis in an unprecedented scenario that concerns people across geographic areas and of varying socioeconomic status. In such a context, knowledge develops in a short time frame and, to be most effective, needs to be acquired and put into practice quickly. While the rapid dissemination of information during the COVID-19 crisis may have widened knowledge gaps, with higher educated people possessing more crucial information than others (Tichenor et al., 1970), it may also be that public health efforts to reach all audiences ended up avoiding knowledge gaps. It is this empirical question that this article addresses.

Extending the Knowledge Gap Hypothesis to Fake News Beliefs

A particular concern during the COVID-19 pandemic has been the widespread diffusion of misinformation or fake news both on social media and via traditional media (Sharma et al., 2020). The Pew Research Center reported that 80% of Americans had seen fake news about the coronavirus already during the early days of outbreaks in the United States (Jurkowitz & Mitchell, 2020b). Moreover, those who primarily got their news on social media were least likely to follow news on COVID-19, but more likely to say they had encountered fake news about this topic (Jurkowitz & Mitchell, 2020a). While measuring who can identify misinformation is not the equivalent of knowing how much fake news is out there, these findings certainly

suggest that people were encountering diverse information from early on in the pandemic, some of it of questionable quality. More generally, prior work has found that there is fake news on social media, even if perhaps not as much as some might assume (Grinberg, Joseph, Friedland, Swire-Thompson, & Lazer, 2019; Guess, Nagler, & Tucker, 2019).

Similar trends have been observed in other countries. For instance, a report by Ofcom (2020) shows that half of respondents reported that they had encountered fake news about COVID-19 during the first week of lockdown in the United Kingdom. Even by the third week, a third (32%) still said that they found it hard to know what is true or false about COVID-19 news. The uncertainties around the novel coronavirus even led to the inclusion of nonconfirmed information in early scientific literature on the issue (Ioannidis, 2020), highlighting the scope and impact of misinformation during the pandemic.

While there is evidence that less educated people are less careful and critical toward fake news overall (Allcott & Gentzkow, 2017; van Prooijen, 2017), few studies have looked at whether education level matters when it comes to believing fake news. One study among Internet users from seven countries found that people with lower socioeconomic status and lower educated older adults are more susceptible to online fake news (Dutton & Fernandez, 2019). Another study on the 2016 U.S. presidential election showed that higher education level was associated with more accurate news beliefs (Allcott & Gentzkow, 2017). Specific to COVID-19 news, data from the Pew Research Center (Jurkowitz & Mitchell, 2020a) showed that higher educated citizens find it easier to separate fact from fiction and are overall more confident in that they can fact-check news. Together, these findings suggest that people with lower education levels are more susceptible to believing fake news as true. While research on misinformation has a long history in communication scholarship, studies focusing specifically on fake news are much more recent and not as clearly linked with specific sources as work identifying sources of knowledge. That said, most work on fake news tends to be preoccupied with online sources, and social media in particular, as the channel where such content is most likely to spread (Grinberg et al., 2019; Guess et al., 2019).

Hypotheses

Informed by the literature reviewed in the previous section, this study tests the knowledge gap hypothesis on a U.S. national sample a few weeks after the pandemic outbreak there. It focuses on evaluating whether education level, as moderated by the use of traditional (i.e., television, newspapers, radio) and digital media (i.e., social media, online news, government and health-related websites) to get information about COVID-19, widens knowledge gaps and contributes to divides in fake news acquisition.

Overall, previous literature suggests that higher educated people can rely on higher levels of general (health) knowledge, greater communication skills, and greater ability to acquire information, especially in the short run. With respect to fake news acquisition, they likely more easily identify relevant facts and distinguish between true and fake news in a saturated information environment. As such, we first hypothesize that:

H1a: Higher education is related to higher levels of knowledge about COVID-19.

H1b: Higher education is related to lower levels of fake news beliefs about COVID-19.

In line with previous literature on knowledge gaps and the role of traditional news media in the process, we expect television to reach a wider audience of citizens and provide more reliable informational programs, thus stimulating factual knowledge and decreasing education-based knowledge gaps more so than other traditional media such as newspapers and radio news. Moreover, traditional media will minimally contribute to differences in fake news beliefs between those with different education levels. Specifically, we hypothesize that:

H2a: More frequent use of television to get informed about the pandemic decreases the COVID-19 knowledge gap between less and more educated people, while this is not the case for newspapers and radio news.

H2b: More frequent use of traditional media (television, radio, and newspapers) to get informed about the pandemic does not lead to a greater gap in fake news beliefs between less and more educated people.

With respect to digital media, the literature suggests that they amplify already-present knowledge gaps, given the complexity of gathering credible information online. Regarding fake news acquisition on social media, false and unverified news can circulate freely and is not vetted for accuracy, and the widespread sharing of non-searched-for information ("push" experience) can lead to incidental exposure. Overall, we expect the more educated segments of the population to be able to manage information coming from social media more effectively. Because issues of unreliable information are less salient for other Internet news sources (e.g., news-only websites, government websites) besides social media, we expect these to have less of an impact on the relationship between education level and fake news beliefs. Here, we hypothesize that:

H3a: More frequent use of Internet news to get informed about the pandemic increases the COVID-19 knowledge gap between less and more educated people.

H3b: More frequent use of Internet news does not lead to a greater gap in fake news beliefs between less and more educated people.

H4a: More frequent use of social media to get informed about the pandemic increases the COVID-19 knowledge gap between less and more educated people.

H4b: More frequent use of social media is related to higher levels of fake news beliefs about COVID-19 for less educated people, whereas this is not the case for more educated people.

Data and Method

Data Collection

We administered a survey to 1,374 U.S. adults in the period April 4–8, 2020, approximately three weeks after lockdown measures had been introduced in several states. We contracted with the online research firm Cint to distribute the survey among a national panel of Internet users. Respondents were

financially compensated for their participation. To achieve a diverse sample reflecting U.S. Census figures, we set quotas for age, gender, education level, and region. Our final sample includes respondents from all 50 U.S. states plus Washington, DC.

Measures

Sociodemographic Characteristics

Table 1 presents the sample descriptives. We measured educational attainment as the highest level of school completed from among six options. We dichotomized the variable to distinguish people who obtained at least a bachelor's degree (higher educated, 30% of the sample) from the rest of the sample. We asked people the year they were born, which we used to calculate their age ($\bar{x} = 46$). We asked whether respondents were male, female or other, and we created a dummy for female (54%; 1 person had indicated "other"). We measured household income in categories, which we recoded to midpoint values ($\bar{x} = \text{US\$}59,104$). To assess race and ethnicity, we followed the U.S. Census form's conventions of first asking whether the respondent is "of Hispanic or Latino descent" and then asking which racial category applied. We recoded these to mutually exclusive categories of White (65%), Hispanic (15%), Black/African American (13%), Asian (5%), American Indian or Alaska Native, and Native Hawaiian or Pacific Islander (2% for these two categories together).

Table 1. Descriptive Statistics of the Sample (N = 1,374).

Variable	M (SD)		Frequency (%)	
Age	45.6	(15.9)		
Gender				
Male			633	(46.0)
Female			740	(53.9)
Race and ethnicity				
White			884	(64.3)
Hispanic			208	(15.1)
Black			174	(12.7)
Asian			68	(5.0)
Native American			29	(2.1)
Educational level				
Up to associate's degree			969	(70.5)
Bachelor's degree or more			405	(29.5)
Income (in US\$)	59,103	(52,156)		
Living alone				
No			1,067	(77.6)
Yes			307	(22.3)
Living with children				
No			899	(65.4)
Yes			475	(34.6)

Variable	<i>M (SD)</i>	Frequency (%)
Medical conditions		
No		862 (62.7)
Yes		512 (37.3)
Closely following news about COVID-19		
No		513 (37.3)
Yes		861 (62.7)
Search for answers		
No		1,093 (79.6)
Yes		281 (20.4)
Info: Television		
Never		99 (7.2)
Few times a week or less		343 (25.0)
Daily		931 (67.8)
Info: Radio		
Never		699 (50.9)
Few times a week or less		425 (30.9)
Daily		238 (17.3)
Info: Newspaper/magazine		
Never		603 (43.9)
Few times a week or less		405 (29.5)
Daily		355 (25.8)
Info: Social media (Facebook, Instagram, Twitter)		
Never		418 (30.4)
Few times a week or less		412 (30.0)
Daily		541 (39.4)
Info: Seeking on Internet (online news, websites)		
Never		208 (15.1)
Few times a week or less		482 (35.1)
Daily		683 (49.7)

We included measures of respondents' household composition—specifically if they live alone (22%) and, if not, whether they live with children under the age of 18 (35%)—to control for potential changes in media exposure resulting from the social isolation imposed by the lockdown. Indeed, living with family during the lockdown involves sharing of spaces, increasing daily interactions, and, especially for parents, caring responsibilities. Such changes can contribute to a reduction in time and opportunities for media consumption and information seeking. Staying home alone for weeks without being able to meet family and friends in person, on the contrary, can make media consumption the main way to escape forced isolation, encouraging individual exposure to COVID-19 information as well as other content.

We also asked whether respondents had any of eight listed preexisting medical conditions (high blood pressure, diabetes, cardiovascular/heart disease, chronic respiratory/lung disease, cancer, weakened immune system, use of immunosuppressive medication, pregnancy) that would put them in a high-risk group concerning COVID-19 (37%) and included a dummy for this because such people may have more reasons to follow COVID-19-related news closely. Finally, we directly collected participants' perceptions of how closely they followed news about the outbreak of COVID-19 and created a dummy variable to control for those who answered "very closely" (63%).

Use of Traditional and Digital Media Sources

We asked respondents how often they get information about COVID-19 from a list of sources that included both traditional and digital media. Traditional sources included television news channels (ABC, CBS, NBC, PBS, Fox News, MSNBC, CNN, other cable news channels or late-night talk shows), radio stations (National Public Radio or other radio) and traditional print media (national newspaper, local newspaper, or magazines). For all of these, we specified access either online or offline. Digital media sources included social media platforms (Facebook, Twitter, and Instagram) and websites (online-only news media, government websites, health websites, websites displaying numbers about the global spread of the virus, and its spread in the United States). The battery of items on media use provided three answer categories asking participants to report whether and how often they use the mentioned sources: never, few times a week or less, daily, or almost daily.

Knowledge

We measured participants' knowledge about COVID-19 through eight knowledge questions. Five of these were multiple choice with one correct answer of four options, and three were true-or-false questions. We developed the items based on official communication from the World Health Organization (WHO).¹ The questions were designed to capture respondents' knowledge about the incubation time of the virus, common symptoms of COVID-19, effective procedures of social distancing to reduce the risk of being infected and infecting others, and the action to be taken in case of assumed contagion (see the exact wording of the items in Table 2). After these questions, we also asked respondents whether they had done "an online search (such as using Google) to help answer the questions." We included a dummy variable if people had done any searching for answers to control for possibly getting help with the responses.

Fake News Beliefs

We measured false knowledge acquisition about COVID-19 through a battery of 10 true-or-false questions. The questions asked which of the listed behaviors represent effective ways to reduce the risk of being infected by the Coronavirus (Table 2). Instead of considering the proper behaviors suggested by the WHO, as done for the knowledge test, we focus on a set of fake news reported on the WHO website (e.g., taking vitamin C, eating freshly boiled garlic, avoiding buying products made in China). For the true-or-false

¹ We used information for the public retrieved from the WHO website (see <https://www.who.int/westernpacific/emergencies/covid-19/information>).

questions, we mixed knowledge and fake news items in the same battery of questions. To answer correctly, respondents had to mark knowledge items as “true” and fake news items as “false.”

Table 2. Questions Included in the Knowledge and Fake News Beliefs Tests.

Knowledge items	Question type	Respondents giving the correct answer (%)
<i>Below are some questions about the Coronavirus pandemic (COVID-19). Please select the correct answer to these questions. If you don't know the correct answer, take your best guess.</i>		
What should you do if you have come into close contact with infected people?	MC	980 (71)
Self-quarantine by staying at home as a precaution (c)		
Make frequent nasal washings		
Go to the doctor and ask to get tested for the virus		
Go out only for work or health reasons		
What are the common symptoms of COVID-19?	MC	1,265 (92)
Fever and dry cough (c)		
Abdominal pain and cramps		
Upset stomach and nausea		
Headache and dizziness		
How long does it take between catching Coronavirus and beginning to have symptoms?	MC	1,160 (84)
A few minutes		
One day		
Up to two weeks (c)		
Up to two months		
Who is most at risk of serious health consequences of COVID-19?	MC	1,289 (94)
Older people with certain preexisting medical conditions (c)		
Children, which is why schools are now closed		
Pregnant women		
People of Chinese descent		
What can be said about people who have been tested positive for COVID-19 but are in good health?	MC	1,113 (81)
They are not contagious until they show clear symptoms		
They are definitely going to show symptoms within a few days		
They are contagious regardless of whether they show symptoms (c)		
They are already immunized and can go out in public		
<i>What are ways to reduce the risk of being infected by the Coronavirus? If you do not know, please give it your best guess.</i>		
Keep a distance of 6 feet with other people	T/F	1,233 (90)
Avoid shaking hands with people	T/F	1,208 (88)

Avoid leaving your home	T/F	1,127 (82)
		Respondents believing fake news (%)
Fake news beliefs items	Question type	
<i>What are ways to reduce the risk of being infected by the Coronavirus?</i>		
<i>If you do not know, please give it your best guess.</i>		
Take vitamin C	T/F	492 (36)
Avoid buying products made in China	T/F	295 (22)
Drink hot fluids	T/F	282 (21)
Avoid receiving packages from the postal service	T/F	232 (17)
Take hot baths	T/F	221 (16)
Avoid taking anti-inflammatory drugs	T/F	181 (13)
Frequently rinse your nose with saline (salty water)	T/F	168 (12)
Eat freshly boiled garlic	T/F	86 (6)
Avoid consumption of meat products	T/F	71 (5)
Avoid consumption of dairy products	T/F	63 (5)

Note. MC = multiple choice; T/F = true or false.

Data Analysis

We first evaluated the dimensionality and factorial validity of the knowledge and fake news belief tests using confirmatory factor analysis (CFA). Specifically, we estimated a CFA that examined the properties of a single-factor model combining COVID-19 knowledge and fake news beliefs, and compared that against a two-factor model distinguishing them in two distinct and interrelated constructs. The analyses were performed using a robust weighted least square estimation method (WLSMV) to deal with dichotomous variables (Asparouhov & Muthén, 2010). We assessed model fit for the two alternative specifications using the chi-square statistic (χ^2). To correct for chi-square inflation with large sample sizes (Chen, 2007), we additionally used the root mean squared error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker–Lewis index (TLI) as a measure of model fit. Following Hu and Bentler (1999), CFA suggested that a two-factor solution based on the assumption that respondents' knowledge and fake news beliefs represent distinct constructs had an adequate model fit ($\chi^2 = 455$, $df = 134$, $p < .001$; RMSEA = .042 [.038, .046]; CFI = .939; TLI = .931); this was better than a one-factor solution, which resulted in an unsatisfactory model fit ($\chi^2 = 1352$, $df = 135$, $p < .001$; RMSEA = .081 [.077, .085]; CFI = .770; TLI = .739). The standardized loadings of the two-factor solution exhibited values ranging from .554 to .834 for knowledge and from .450 to .848 for fake news beliefs, while an interfactor correlation equal to -.406 suggests the existence of a negative relationship between the knowledge and the fake news beliefs tests scores. In other words, the more participants know about COVID-19, the less likely they are to believe misinformation about how to behave to reduce the risk of contagion. In sum, we have two latent constructs measuring different, but negatively correlated, concepts. Based on the Kuder-Richardson Formula 20, a sufficient degree of internal reliability was confirmed for the two latent constructs, with values of .744 for the knowledge and .702 for the fake news

beliefs tests, respectively. As factor loadings consistently vary between the items, we opted for using standardized latent-trait scores of the knowledge and fake news beliefs tests, estimated with a maximum a-posteriori method (MAP). This optimal weighting strategy—contrary to the calculation of simple summative scores—takes into account that different items can relate differently to the latent construct (McNeish & Wolf, 2020).

We then proceeded with a first stage of analysis based on a set of linear regression models (OLS). First, we modeled how participants' education levels and frequency of traditional and digital media use as information sources predict knowledge and fake news beliefs. Second, we replicated the same models with the addition of interaction terms between education levels and each indicator of frequency of media use. These multiple-interaction models were aimed at evaluating whether the hypothesized knowledge gaps registered in previous analyses are moderated by varying frequencies of traditional and digital media use. All models presented in the study include as covariates sociodemographics, household composition, health status, whether people followed news about COVID-19 closely, and whether someone looked up answers on the knowledge test.

Results

Table 3 shows the results from two regression models that we estimated to examine the robust associations of education level as well as traditional and digital media consumption with COVID-19-related knowledge and fake news beliefs. As shown in the first line of the table, education level is positively associated with knowledge ($\beta = .116, p = .044$), whereas fake news beliefs are not significantly predicted by it. Therefore, we can confirm H1a, but reject H1b. Moving to the role of traditional sources of information, television news consumption is related significantly neither to knowledge nor to fake news beliefs. However, radio consumption and print media consumption are negatively related to knowledge and positively related to fake news beliefs. With respect to radio news, as frequency of use increases, knowledge levels decline (weekly: $\beta = -.117, p = .041$; daily: $\beta = -.219, p = .003$), while fake news beliefs increase (weekly: $\beta = .101, p = .093$; daily: $\beta = .311, p < .001$). Reading print newspapers and magazines on a daily basis relates to lower knowledge ($\beta = -.203, p = .002$), while fake news beliefs increase as a result of daily print media consumption ($\beta = .142, p = .042$). With respect to digital media sources, our results show that both weekly and daily social media use for COVID-19 information is negatively related to knowledge (weekly: $\beta = -.155, p = .017$; daily: $\beta = -.184, p = .004$), while positively related to fake news beliefs (weekly: $\beta = .338, p < .001$; daily: $\beta = .424, p < .001$). As for news consumption through information websites, there are no significant effects for either knowledge or fake news acquisition.

Table 3. Results of the Regression Models on Knowledge and Fake News Beliefs, Standardized Test Scores.

Variables	Knowledge		Beliefs in Fake News	
	β	SE	β	SE
Education: Bachelor's or more	0.116*	(0.058)	-0.038	(0.060)
Info: Television (ref. Never)				
Few times a week or less	0.147	(0.102)	-0.098	(0.107)
Daily	0.167	(0.098)	-0.124	(0.103)
Info: Radio (ref. Never)				
Few times a week or less	-0.117*	(0.057)	0.101	(0.060)
Daily	-0.219**	(0.073)	0.311***	(0.076)
Info: Newspapers/magazines (ref. Never)				
Few times a week or less	-0.004	(0.059)	0.000	(0.061)
Daily	-0.203**	(0.067)	0.142*	(0.070)
Info: Social media (ref. Never)				
Few times a week or less	-0.155*	(0.065)	0.338***	(0.067)
Daily	-0.184**	(0.064)	0.424***	(0.067)
Info: Seeking on Internet (ref. Never)				
Few times a week or less	0.086	(0.076)	-0.006	(0.079)
Daily	0.090	(0.079)	0.043	(0.082)
Female	0.177***	(0.048)	-0.082	(0.050)
Age	0.007***	(0.002)	-0.006**	(0.002)
Race/ethnicity (ref. White)				
Hispanic	-0.114	(0.069)	0.024	(0.072)
Black	-0.366***	(0.074)	0.176*	(0.077)
Asian	0.141	(0.111)	0.230*	(0.116)
Native	-0.2142	(0.167)	0.150	(0.174)
Income log	0.131***	(0.028)	-0.029	(0.030)
Living alone	-0.002	(0.064)	0.121	(0.066)
Living with children	-0.127*	(0.058)	0.085	(0.061)
No medical conditions	0.004	(0.051)	0.069	(0.054)
Closely following news	0.086	(0.054)	0.019	(0.056)
Search for answers	-0.742***	(0.062)	0.559***	(0.065)
N	1,350		1,350	
R ²	0.273		0.219	

* $p < .05$. ** $p < .01$. *** $p < .001$.

The subsequent set of regression models (Table 4) tests whether the frequency of use of all the mentioned sources of information contributes to the widening of knowledge and fake-news-belief gaps across respondents with low and high levels of education. Here, we hypothesized that more frequent use of television would decrease education-based knowledge gaps, whereas newspapers and radio news would not (H2a). Moreover, we expected that more frequent use of traditional news in general would not lead to greater education-based gaps in having fake news beliefs (H2b). Our analyses show no significant interaction effects for

traditional news sources (i.e., television, newspapers, and magazines, and radio), for either knowledge or fake news acquisition as outcomes. As such, we partially reject H2a, but confirm our expectations around H2b.

Table 4. Results of the Multiple-Interaction Regression Models on Knowledge and Fake News Beliefs, Standardized Test Scores.

Variables [^]	Knowledge		Beliefs in Fake News	
	β	SE	β	SE
Education: Bachelor's or more	0.009	(0.257)	-0.043	(0.268)
Info: Television (ref. Never)				
Few times a week or less	0.164	(0.118)	-0.075	(0.123)
Daily	0.195	(0.113)	-0.123	(0.118)
Education*Info: Television				
Few times a week or less	-0.059	(0.237)	-0.041	(0.248)
Daily	-0.074	(0.223)	0.020	(0.233)
Info: Radio (ref. Never)				
Few times a week or less	-0.112	(0.069)	0.047	(0.072)
Daily	-0.303**	(0.090)	0.274**	(0.094)
Education*Info: Radio				
Few times a week or less	0.013	(0.124)	0.166	(0.129)
Daily	0.246	(0.153)	0.122	(0.160)
Info: Newspaper/magazine (ref. Never)				
Few times a week or less	0.024	(0.070)	-0.064	(0.073)
Daily	-0.230**	(0.082)	0.160	(0.085)
Education*Info: Newspaper/magazine				
Few times a week or less	-0.086	(0.131)	0.212	(0.137)
Daily	0.056	(0.143)	-0.010	(0.149)
Info: Social media (ref. Never)				
Few times a week or less	-0.153*	(0.077)	0.359***	(0.080)
Daily	-0.137	(0.076)	0.426***	(0.079)
Education*Info: Social media				
Few times a week or less	-0.033	(0.138)	-0.063	(0.144)
Daily	-0.167	(0.137)	-0.030	(0.143)
Info: Seeking on Internet (ref. Never)				
Few times a week or less	0.042	(0.086)	0.032	(0.090)
Daily	0.045	(0.088)	0.073	(0.092)
Education*Info: Seeking on Internet				
Few times a week or less	0.217	(0.189)	-0.133	(0.197)
Daily	0.236	(0.192)	-0.124	(0.200)
N	1,350		1,350	
R ²	0.277		0.223	

* $p < .05$. ** $p < .01$. *** $p < .001$.

[^]Covariates are included in all regression models, but not reported here because of space constraints.

With respect to digital media sources, we hypothesized that more frequent use of information websites as a news source would lead to a greater education-based knowledge gap (H3a), but not contribute to greater education-based differences in fake news beliefs (H3b). Given that there are no significant interaction effects, we reject H3a and confirm H3b. For social media as a news source, we expected that more frequent use of social media would increase education-based knowledge gaps (H4a), as well as contribute to education-based differences in fake news acquisition (H4b). Given that these interaction effects were not significant, we reject both H4a and H4b.

Discussion and Conclusion

During nationwide health crises, when timely information is of the essence, states and public health organizations should focus on making sure that all people are adequately informed. This study investigated who was better informed a few weeks after the outbreak of the pandemic in the United States, how media consumption contributed to COVID-19 knowledge and fake news beliefs, and whether media use affected their distribution across less and more educated people.

In line with a strong body of research on the knowledge gap hypothesis (see Hwang & Jeong, 2009; Lind & Boomgaarden, 2019), this study indicates that in the first phase of the pandemic, an education-based knowledge gap about COVID-19-related risks and precautions indeed existed. Higher educated people (i.e., those with at least a bachelor's degree) reported higher levels of knowledge than their lower educated counterparts. At the same time, we observed no significant differences between people with varying educational levels on how much fake news they believed on the matter. Second, we found that the relationship between education level and knowledge, and the relationship between education level and fake news beliefs about COVID-19 were not moderated by people's news media consumption. This suggests that during the early months of the COVID-19 pandemic, traditional and digital media were not widening or closing the COVID-19 knowledge gap across people of different educational backgrounds.

Our study contributes to the literature by examining the knowledge gap hypothesis in a scenario in which knowledge acquisition happened in a relatively short time span, namely, a public health crisis of global scale. As such, we add to the body of previous literature that has mainly addressed knowledge about topics that are acquired over longer periods (see Barabas et al., 2014). A first implication of the knowledge gap we found is that such differences may partly explain why those of lower socioeconomic status are more severely impacted by COVID-19 (Dobransky & Hargittai, 2020; Mansoor, 2020). That is, people who understood the virus less and had less appreciation for what measures to take to avoid it may have been more prone to being exposed to it. Second, given that there is no strong evidence that media consumption can make up for education-based knowledge gaps, our findings suggest that those with a lower education level are at a structural disadvantage when it comes to learning about guidelines to limit the spread of COVID-19 and protecting themselves and others. If the media do not differentially contribute to knowledge acquisition for people with varying education levels, then knowledge gaps are mostly based on previous knowledge or on the ability to interpret new information through the lens of existing information literacy (Koltay, 2011).

In contrast with previous research suggesting that less educated people are more susceptible to misinformation (Allcott & Gentzkow, 2017; van Prooijen, 2017), we did not find that education level mattered for the acquisition of fake news about COVID-19 in the pandemic's early weeks. Rather, misinformation seemed to spread equally across education levels, not impacting lower educated people more than those with higher education levels. It could be that the short temporal span we considered in light of the COVID-19 pandemic did not allow the necessary time, even for the more skilled, to distinguish what was true from what was false. It could also be that there was so much confusion that even information sources did not communicate a sufficiently clear message to aid in people's understanding of the virus and the ensuing circumstances.

Given that our article addresses the knowledge gap hypothesis and the role of the media in increasing or decreasing this gap, we did not formulate specific hypotheses on the main effects of news media consumption. Nevertheless, an interesting pattern of results emerged concerning the role of various traditional and digital media news sources that are worth discussing here in more depth. Concerning traditional media, we found that the daily use of radio and print media to get information about COVID-19 was related to lower levels of knowledge and higher levels of fake news beliefs, whereas television news consumption did not play a role in this matter. A possible explanation for this is that television is a more universal medium that reaches diverse audiences with a language that everyone can understand (McQuail, 1998). As such, television could be less disorienting in times of informational confusion compared with such sources as radio and print media.

With respect to digital media sources, higher news consumption through social media was associated with lower levels of knowledge and increased levels of fake news beliefs about COVID-19, whereas news consumption through other online sources (e.g., online news media, government websites, health websites) was unrelated to these outcomes. The wide variation in the quality of what kind of information one may obtain online challenges traditional assumptions about the Web necessarily contributing to the dissemination of knowledge. Indeed, while getting informed about COVID-19 using websites did not contribute to related knowledge, social media seem to have enabled rapid dissemination of unverified information through the uncontrolled mechanism of sharing—especially on topics, such as COVID-19, that generate social alarm. These digital media, more than others, appeared as disseminating considerable fake news in the first phases of the pandemic (Jurkowitz & Mitchell, 2020b), making it more difficult for even the highly educated segments of the population to be correctly informed in the short term in an uncertain information environment.

Overall, our findings suggest that while the more educated do better with getting informed about COVID-19, it seems that the impact of the majority of media in this particular context was nonexistent or even detrimental to an informed citizenry. This is in contrast to studies in other contexts supporting the role of media in increasing knowledge levels overall, but also amplifying existing education-based knowledge gaps (e.g., Boukes & Vliegenthart, 2019). If not media, then what may have been the source of people's information during COVID-19? Unfortunately, we did not ask respondents this question directly. One option is that people turned to their social ties for information, not necessarily mediated by social media platforms we asked about, but more directly. Those who had more knowledgeable friends and family able to decipher meaning from the cacophony of information in the early days could have benefited from such ties, and this

might have been more likely for those with higher educational attainment. For example, knowing people in the medical profession may have helped. Future work could dig deeper into the types of information sources people use beyond the media in times of health crises for knowledge acquisition.

Our research offers important insights for public information policies during sudden crises such as that of the new coronavirus. The results of our study confirm that education-based informational disparities have occurred since the beginning of the pandemic. However, this gap is moderate in magnitude compared with the detrimental effects of media use frequency regardless of education level. This implies that policy makers should, on the one hand, find a more effective way to limit the diffusion of unreliable information (e.g., in collaboration with social media platforms) and, on the other hand, work preventively in the long run through massive information education via schools and other institutions such as libraries to equip the population with tools for handling information better than in the COVID-19 case. Educating new generations to deal with unreliable information more consciously might facilitate faster knowledge-acquisition processes in times of emergency. Policy makers should also consider the creation of institutional information packages to be diffused mandatorily and widely across all media in such circumstances for verified information to emerge from the noise. On that point, it is worth noting that our U.S. case is one in which the public-sector media is not particularly strong. This limits the generalizability of our findings to other national contexts. We are hopeful that data were collected during the early months of the COVID-19 pandemic in other countries as well to enable future comparisons.

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